

■ **PM 5150**
ARBITRARY WAVEFORM GENERATOR 20 MS/s

Quick Operating Guide



921111

9499 450 10811



PHILIPS

Quick Operating Guide

INTRODUCTION

This Quick Operating Guide gathers the most frequently needed reference material from the PM 5150 Operating Manual into a small, convenient format. The data is identical to that found in the larger manual, but is provided without explanatory text to permit the speediest access possible.

Usage Tips

Warmup

Remember to allow a 20 minute warmup to be sure the instrument meets all its published specifications.

Output

Make it a habit to check the output indicator. Many operations turn the output off, so remember to include the OUTSW ON command in programs that perform those operations. If there is still no output, also make sure that the instrument is set to the proper mode (continuous, triggered, burst or gate).

Range/Resolution

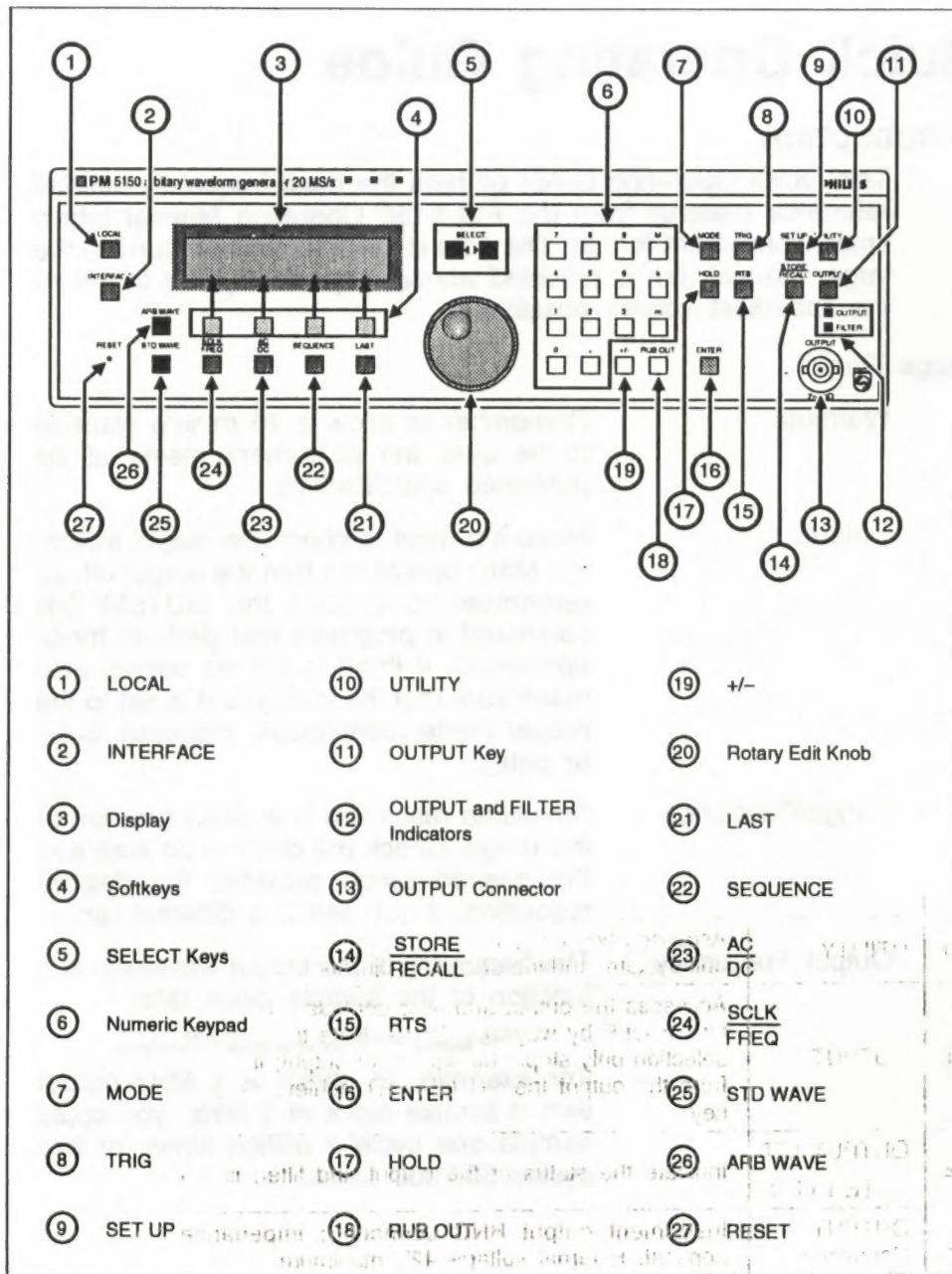
Amplitude resolution is a direct function of the range. Check the chart to be sure that the desired range provides the desired resolution. If not, select a different range.

Output Frequency

The frequency of the output waveform is a function of the sample clock rate:

$$F_{\text{output}} = F_{\text{sample clock}} / N_{\text{samples}}$$

For example, to obtain a 1 MHz output with a sample clock of 1 MHz, you could sample one cycle a million times, or two cycles 500,000 times.



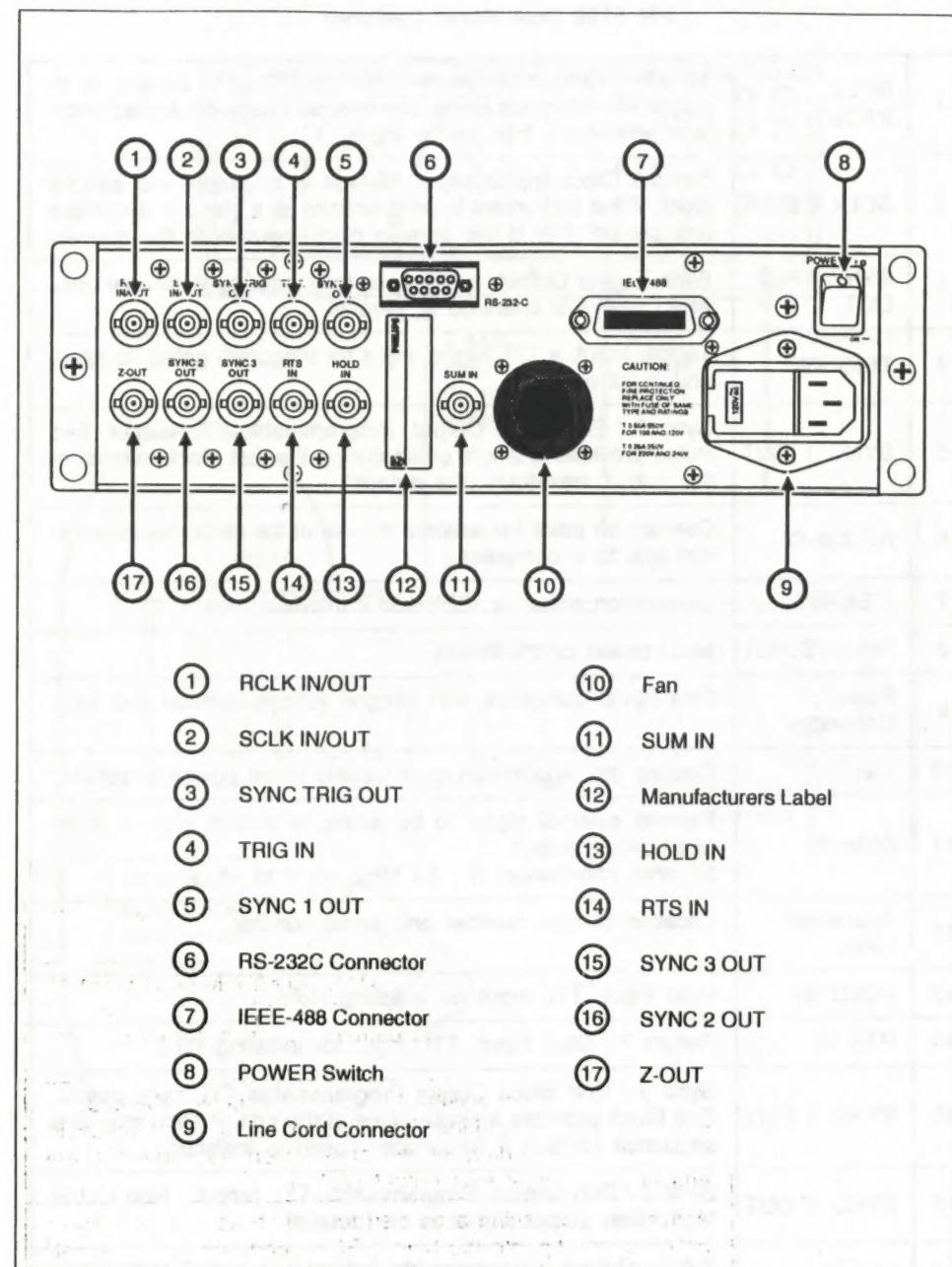
Front Panel

PM 5150 Front Panel Features

| | | |
|----|--------------------------|---|
| 1 | LOCAL | Switches the instrument to local operation. |
| 2 | INTERFACE | Selects GPIB (IEEE-488.2) or RS-232-C remote operation. Softkeys select GPIB address and RS-232 communication parameters (baud rate, parity, data bits, stop bits, handshaking), and DSO facilities. |
| 3 | Display | A two-line by 40-character LCD alphanumeric display. Values, modes, and functions are indicated here. Also, softkey meanings appear in the lower line of the display. Selections change to FULL CAPITAL LETTERS. A triangular indicator may signify that there are more selections available, or point to the currently selected field. |
| 4 | Soft keys | Associated with selections that appear immediately above them in the display, these keys change their use depending on the current operating state. |
| 5 | SELECT keys | These keys choose the currently editable field on the display. |
| 6 | Numeric Input Keys | The numeric keys input values to the PM 5150. Values can be programmed only in decimal from the front panel. Remote operation permits hexadecimal, octal, and binary input as well. |
| 7 | MODE | Selects waveform output mode: Continuous, Triggered, Gated, Burst, or Toggled. |
| 8 | TRIG | Front panel trigger key. Triggers the output in triggered, gated, burst, and toggled modes. |
| 9 | SET UP | Establishes the memory length and synchronization style for standard and arbitrary waveforms. Note that addresses are independently programmable if syncing to an address; however if a default sync mode (End Pulse, Run, or End Block) is chosen for one wave, that style is used for all waves, regardless whether an address is programmed. |
| 10 | UTILITY | Accesses two utility operations; one for setting up a multiple unit system, and the other for adjusting the LCD contrast level. |
| 11 | OUTPUT | Accesses the output and filter controls. These can be turned ON or OFF by way of softkeys. Note that the OUTPUT OFF selection only stops the waveform output; it does not remove from the output the DC OFFSET achieved using the AC/DC key. |
| 12 | OUTPUT LED FILTER LED | Indicate the status of the output and filter; lit = ON. |
| 13 | OUTPUT Connector | Instrument output BNC connector; impedance 50 ohms nominal. External voltage 42V maximum. |

PM 5150 Front Panel Features (cont)

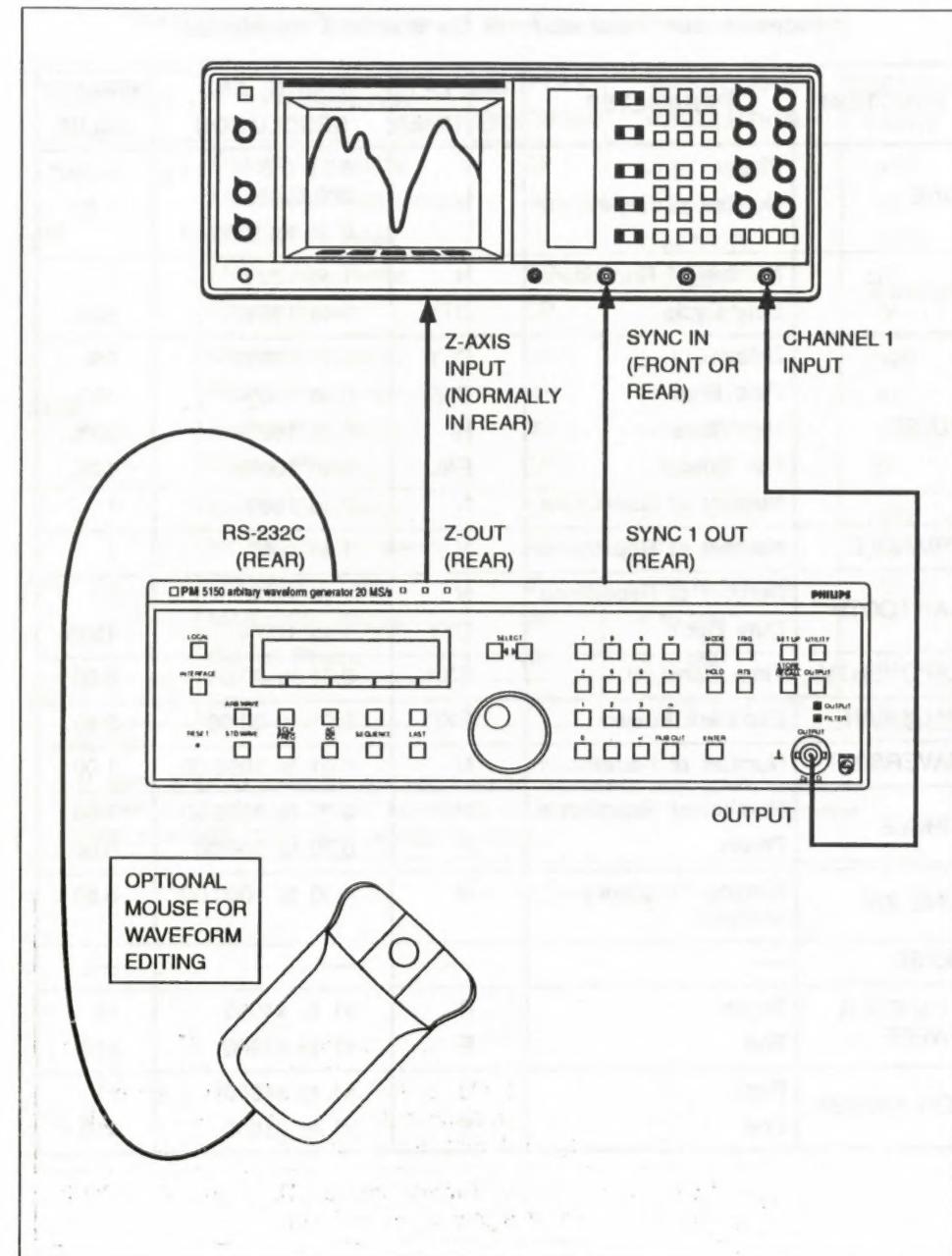
| | | |
|----|-------------------------------|--|
| 14 | <u>STORE</u> <u>RECALL</u> | Stores and retrieves up to 31 sets of complete instrument settings, numbered 0 through 30. See Table 6-2 for a listing of stored and not stored settings. |
| 15 | RTS | Return To Start. This key causes the waveform to begin again from the start point. |
| 16 | ENTER | Terminates keypad entries or command chains. |
| 17 | HOLD | Stops the waveform at its current level. The output remains at that level until HOLD is released. |
| 18 | RUB OUT | Erases the value in the current field. When a value is being edited, RUBOUT clears it digit by digit. |
| 19 | + / - | Changes the sign of the currently displayed value in the field being edited on the display. |
| 20 | Edit knob | Rotary knob used to input waveform parameter values to the instrument. |
| 21 | LAST | Accesses the command input memory. Each successive press of the LAST key cycles the previous command to the display. Command input memory holds the history of about 15 operations. |
| 22 | SEQUENCE | Only functions if the Sequence Generator Option is installed. Permits creation and editing of waveform sequences made up of Arbitrary waves in any order. Standard waves can be sequenced if they are first placed into ARB memories using the EDIT mode. The Sequence Generator option lets you loop between waveform sequences and link them together. |
| 23 | <u>AC</u> <u>DC</u> | Sets the amplitude and offset of the waveform being edited. |
| 24 | <u>SCLK</u> <u>FREQ</u> | Adjusts the sample clock frequency (SCLK) or the frequency of the output waveform. |
| 25 | STD WAVE | Selects a standard waveform. Use SELECT keys to cycle all 20 selections to the display. Use softkeys to select a standard waveform, then a submenu permits adjusting the parameters of the waveform. |
| 26 | ARB WAVE | Selects an arbitrary waveform. Softkeys access submenus to enter Editing mode (Line, Vertex, and Math), View mode to view all or a portion of waveform memory, and set the amplitude of the Z-Axis output (ZLVL). |
| 27 | RESET | Activated by pressing a pointed tool, such as a paper clip or ballpoint pen tip into the hole, RESET performs a "soft reset" when pressed alone, and a "cold start" if held depressed during power on of the PM 5150. See Paragraph 3.2.1 for details. |



3-2. Rear Panel

PM 5150 Rear Panel Features

| | | |
|----|------------------|---|
| 1 | RCLK IN/OUT | 10 MHz Reference Clock; TTL Input/Output. Default is to output the reference clock. The internal crystal-controlled oscillator will phase lock to the input. |
| 2 | SCLK IN/OUT | Sample Clock Input/Output. Default is to output the sample clock. If the instrument is programmed as a slave in a multiple unit set up, this is the sample clock input from the master. |
| 3 | SYNC TRIG OUT | Sync Trigger Output, a TTL sync for triggering additional units when they are operated in parallel. |
| 4 | TRIG IN | Trigger Input, a TTL trigger input for triggered, gated, toggled, and burst modes. |
| 5 | SYNC 1 OUT | Sync 1 / End Pulse Output. Programmable TTL output. End Pulse provides a single pulse during the last clock interval of the output waveform (the default). |
| 6 | RS-232-C | Connection point for optional mouse or for serial communication link to a computer. |
| 7 | IEEE-488 | Connection point for IEEE-488.2 interface bus. |
| 8 | Power Switch | Main power on/off switch. |
| 9 | Power Connector | Line power connector with integral voltage selector and fuse. |
| 10 | Fan | Cooling fan, should run continuously when power is applied. |
| 11 | SUM IN | Permits external signal to be added to output, gain = -2 for open-circuit output. 50 ohm impedance, 0 - 20 MHz, -5 V to +5 V |
| 12 | Instrument Label | Location of type number and serial number. |
| 13 | HOLD IN | Hold Input, TTL input for initiating Hold |
| 14 | RTS IN | Return To Start Input, TTL input for initiating RTS. |
| 15 | SYNC 3 OUT | Sync 3 / End Block Output Programmable TTL sync output. End Block provides a single pulse at the end of each step in a sequence (default if Sequencer option is installed). |
| 16 | SYNC 2 OUT | Sync 2 / Run Output. Programmable TTL output. Run Out is high when output signal is on (default). |
| 17 | Z-OUT | Z-Axis Output, programmable between 0 and 9 volts open circuit, impedance 75 ohms. |



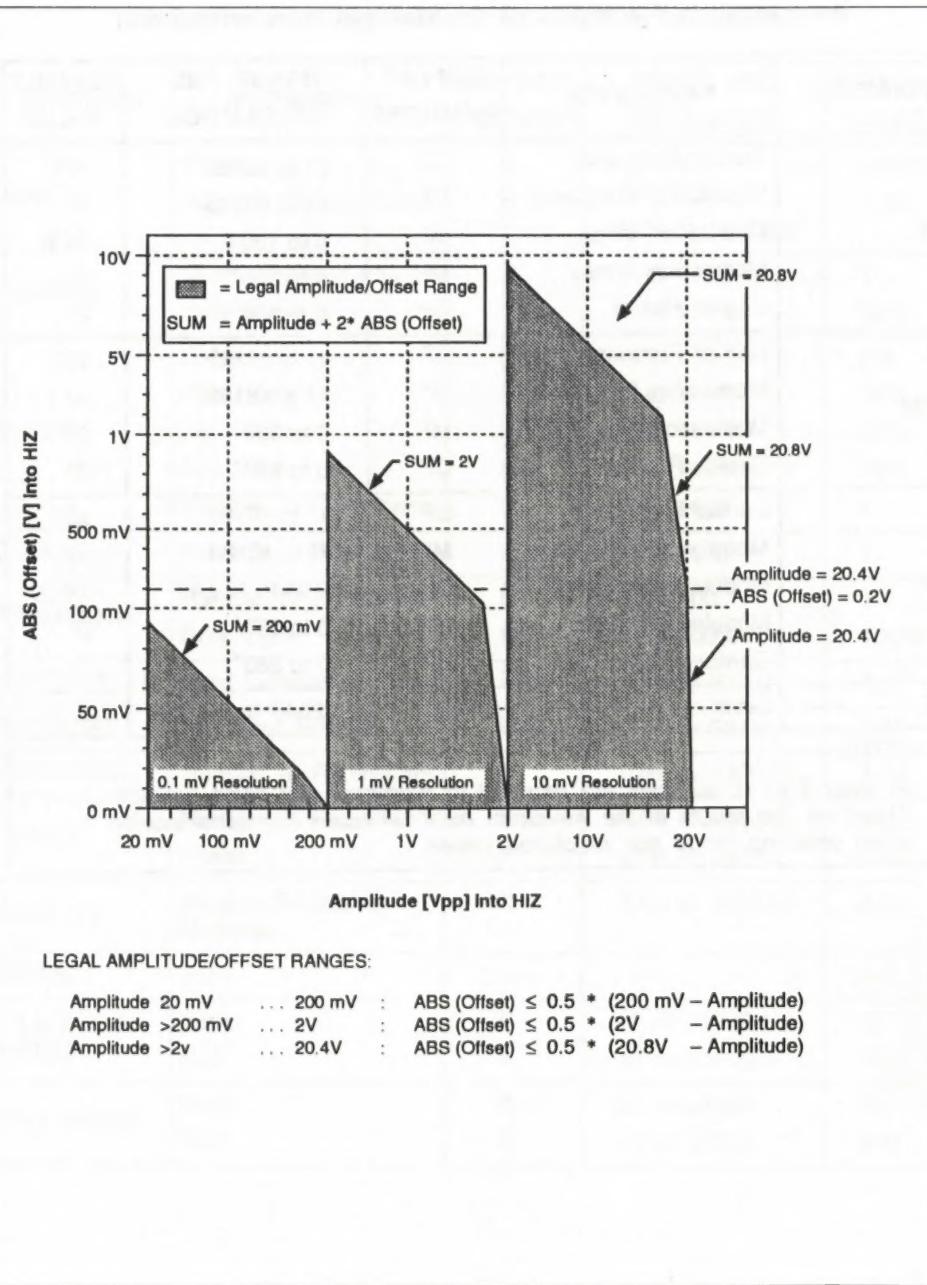
Connections

Programmable Parameters of the Standard Waveforms

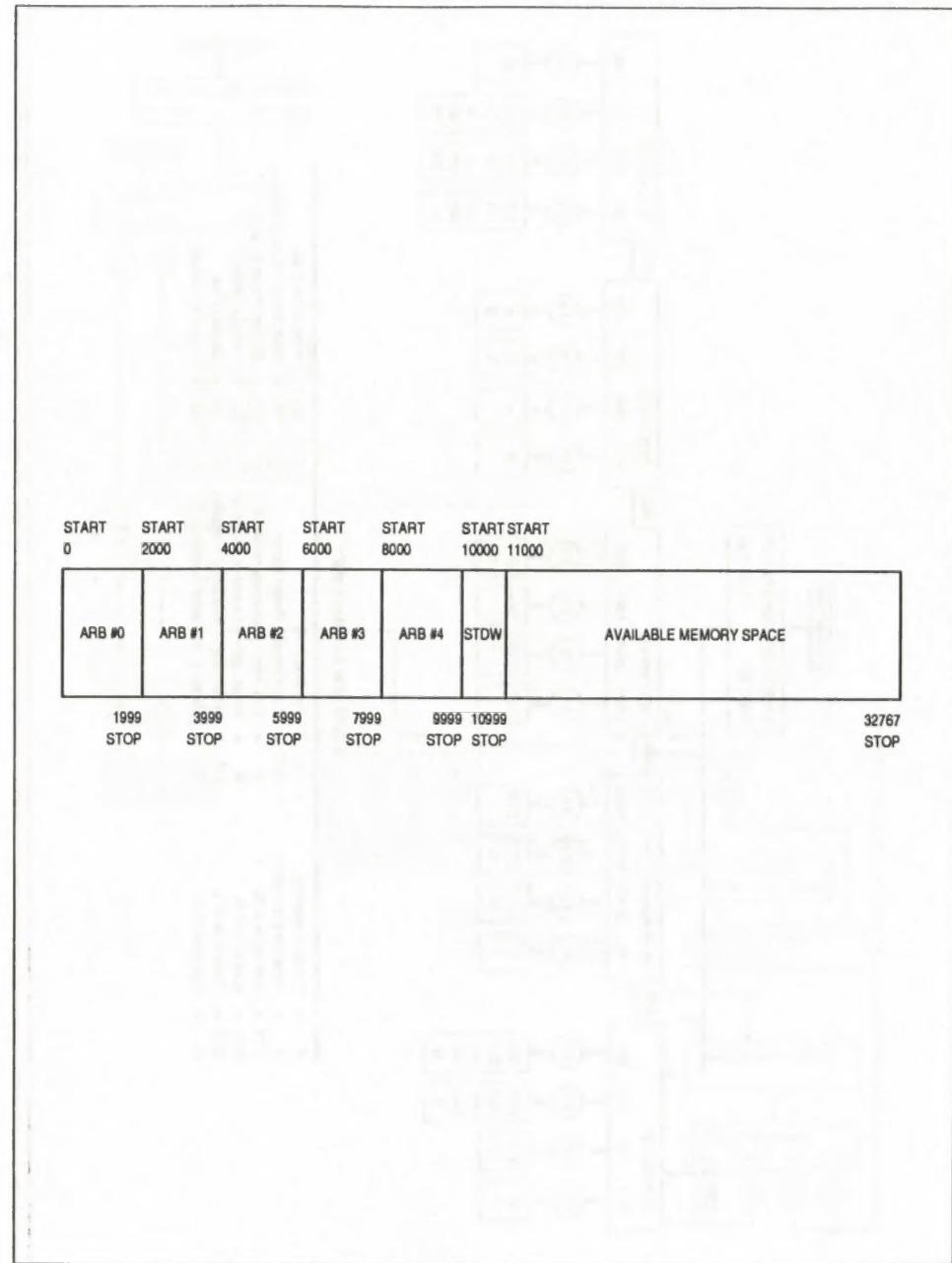
| FUNCTION | PARAMETER | DISPLAY IDENTIFIER | RANGE AND RESOLUTION | DEFAULT VALUE |
|--------------|------------------------------|--------------------|----------------------|---------------|
| SINE | Phase | P | 0.000° to 360.000° | 0.000° |
| | Number of Repetitions | N | 0.01 to 1000.00 | 1.00 |
| SQUARE | Number of Repetitions | N | 1 to 1000 | 1 |
| | Duty Cycle | DTY | 1 to 100% | 50% |
| PULSE | Delay | DLY | 0 to 100% | 0% |
| | Rise Time | RIS | 0 to 100% | 10% |
| | High Time | HI | 0 to 100% | 30% |
| | Fall Time | FAL | 0 to 100% | 10% |
| | Number of Repetitions | N | 0 to 1000 | 1 |
| TRIANGLE | Number of Repetitions | N | 1 to 1000 | 1 |
| SAWTOOTH | Number of Repetitions | N | 1 to 1000 | 1 |
| | Duty Cycle | DTY | 1 to 100% | 100% |
| EXPONENTIAL | Time Constant | EXP | 0.01 to 20.00 | 5.00 |
| GAUSSIAN | Exponent Power | EXP | 0.01 to 20.00 | 2.00 |
| HAVERSINE | Number of Repetitions | N | 0.01 to 1000.00 | 1.00 |
| CIRCLE | Number of Repetitions | N | 0.01 to 1000.00 | 1.00 |
| | Phase | P | 0.00 to 360.00 | 0.00 |
| SINE X/X | Ringing Frequency Multiplier | N | 4.00 to 1000.00 | 5.50 |
| NOISE | — | — | — | — |
| LINEAR SWEEP | Begin | B | x1 to x1000 | x1 |
| | End | E | x1 to x1000 | x10 |
| LOG SWEEP | Begin | B | x1 to x1000 | x1 |
| | End | E | x1 to x1000 | x10 |

Programmable Parameters of the Standard Waveforms (cont)

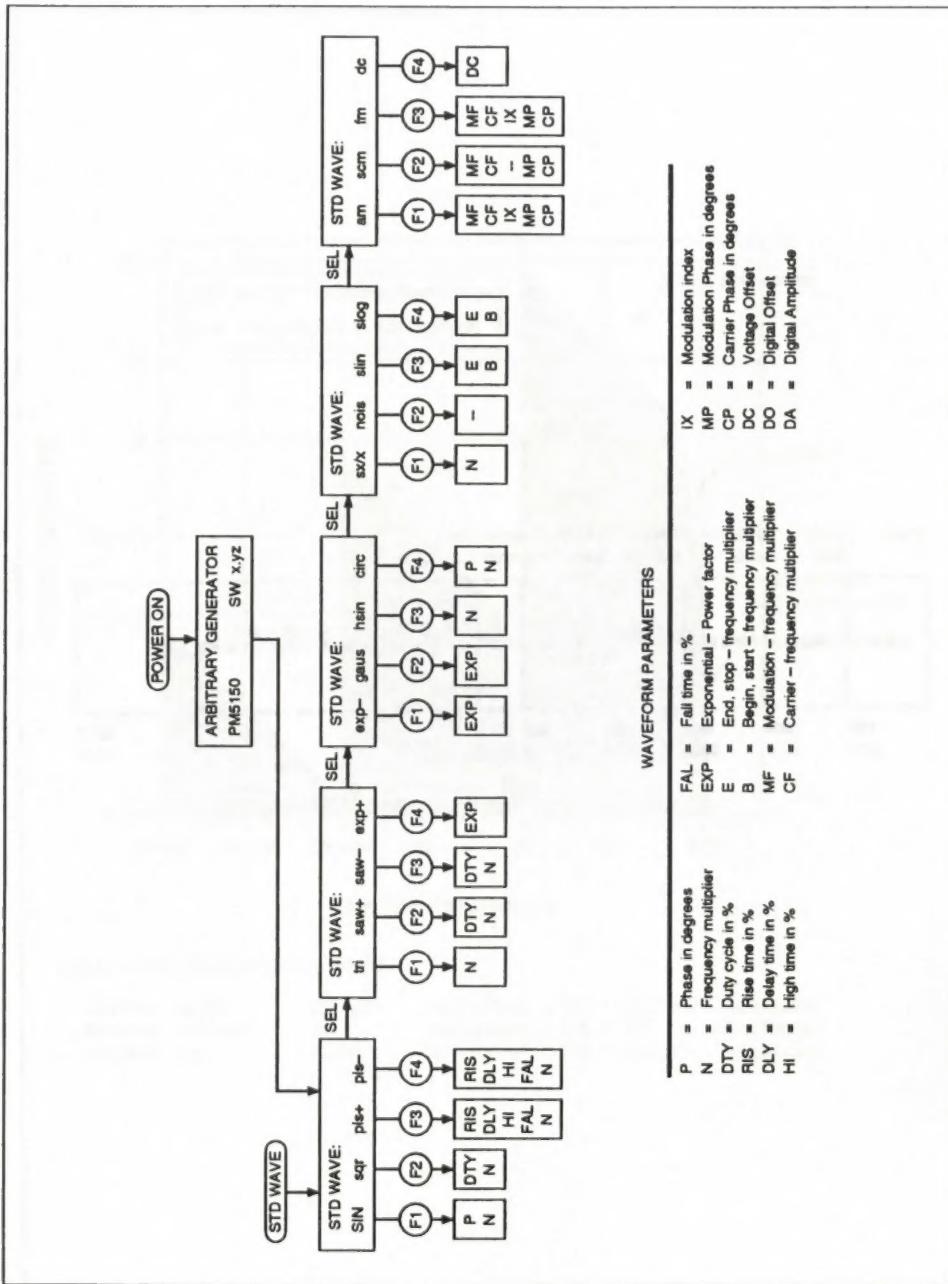
| FUNCTION | PARAMETER | DISPLAY IDENTIFIER | RANGE AND RESOLUTION | DEFAULT VALUE |
|---|----------------------|--------------------|----------------------|---------------|
| AM | Carrier Frequency | CF | x1 to x8183 | x20 |
| | Modulation Frequency | MF | x1 to x8183 | x1 |
| | Modulation Index | IX | 0 to 100% | 50% |
| | Modulation Phase | MP | 0 to 360° | 0° |
| | Carrier Phase | CP | 0 to 360° | 0° |
| SCM | Carrier Frequency | CF | x1 to x8183 | x20 |
| | Modulation Frequency | MF | x1 to x8183 | x1 |
| | Modulation Phase | MP | 0 to 360° | 0° |
| | Carrier Phase | CP | 0 to 360° | 0° |
| FM | Carrier Frequency | CF | x1 to x8183 | x20 |
| | Modulation Frequency | MF | x1 to x8183 | x1 |
| | Modulation Index | IX | 0.01 to 100.00 | 10.00 |
| | Modulation Phase | MP | 0 to 360° | 0° |
| | Carrier Phase | CP | 0 to 360° | 0° |
| DC | Level | DC | -2048 to + 2047 | 0 |
| <i>NOTE:</i> | | | | |
| At least 3 to 10 samples are required to represent any given function. Therefore, the length of the waveform must be taken into consideration when selecting range and resolution values. | | | | |



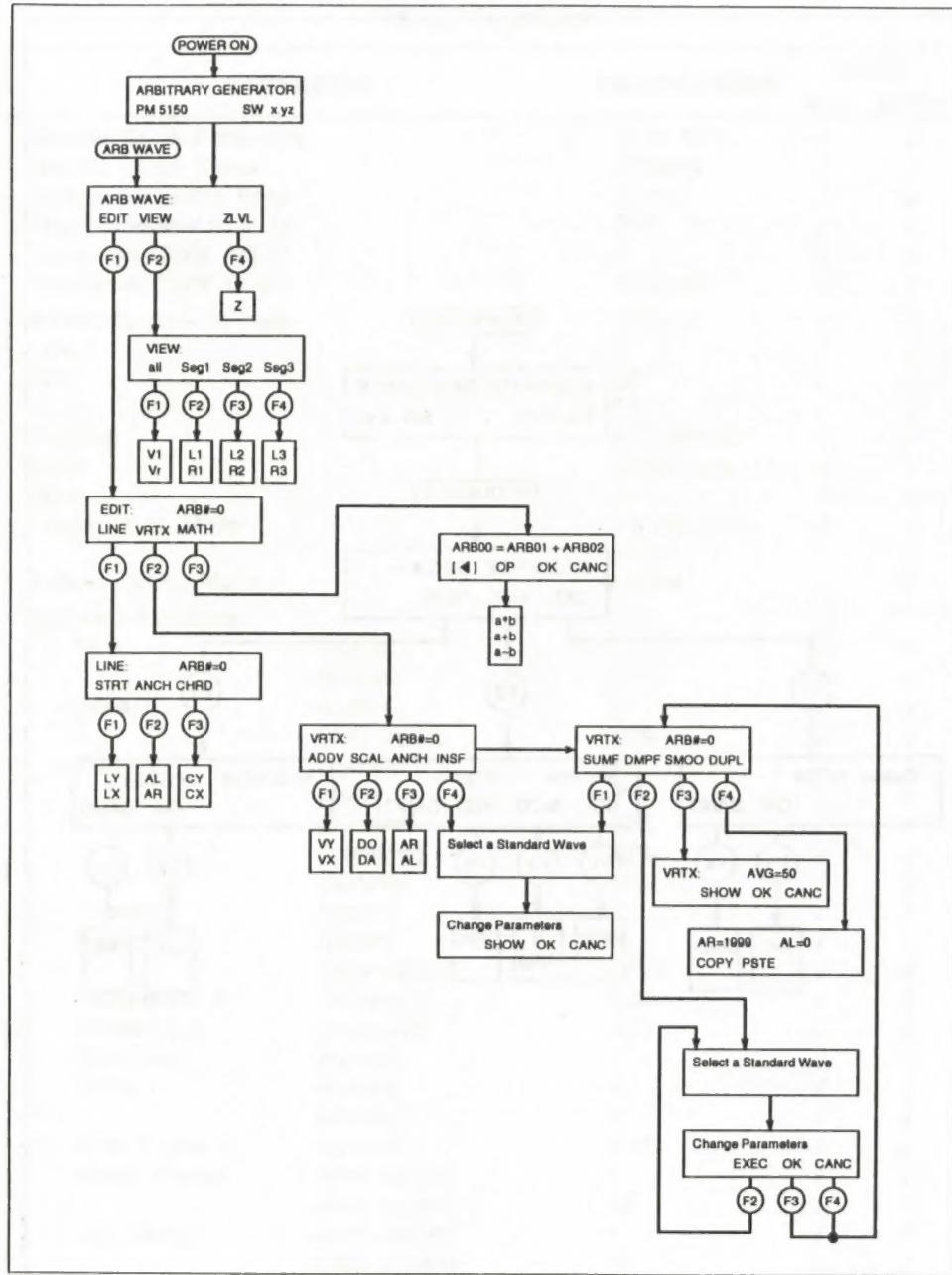
Resolution/Range Graph



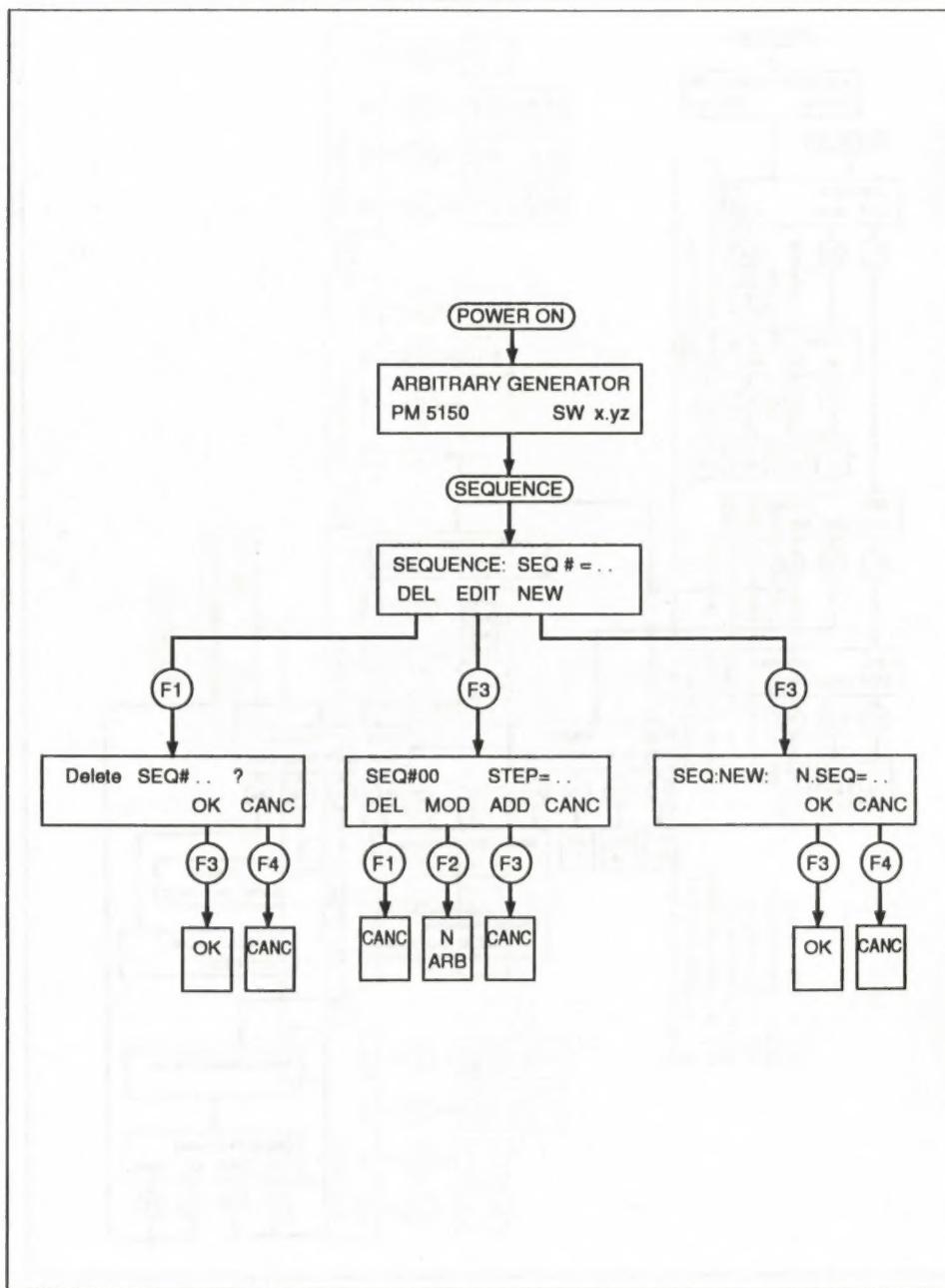
Memory Organization



Standard Wave Function/Menu Tree



Arbitrary Wave Function/Menu Tree



Sequence Generator Option Function/Menu Tree

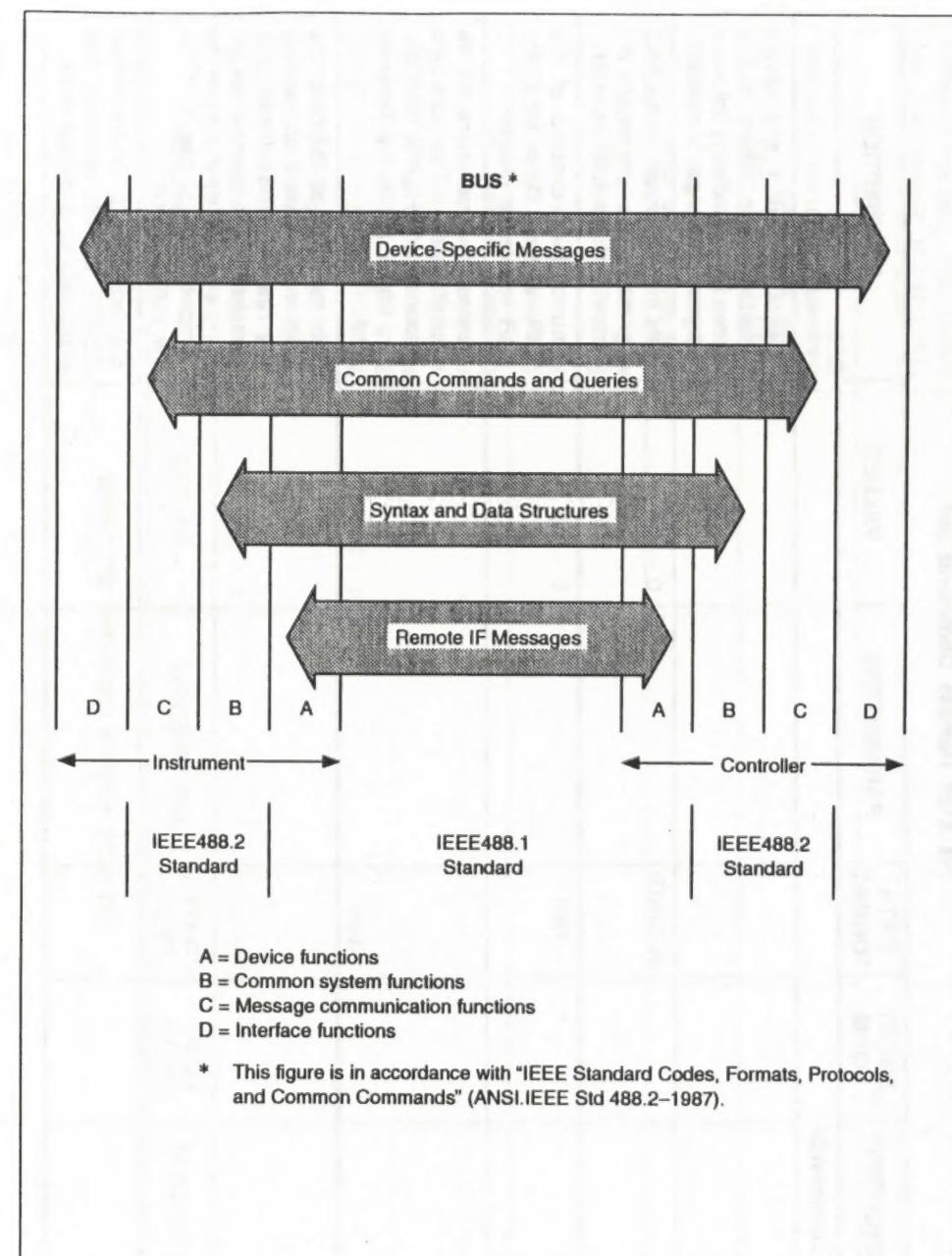
RESET Functions

| PARAMETER | VALUE/STATUS | RESET | |
|-------------------------|---------------------|-------|------|
| | | ALL | CURR |
| Sample Clock Frequency | 10.00 MHz | ✓ | ✓ |
| Sample Clock Select | INTernal | ✓ | ✓ |
| Trigger Generator Rate | 50 mS | ✓ | ✓ |
| Trigger Generator State | OFF | ✓ | ✓ |
| Reference Clock Adjust | 0 | ✓ | ✓ |
| Reference Clock Select | INTernal | ✓ | ✓ |
| Amplitude peak to peak | 10.00 V | ✓ | ✓ |
| Offset | 0 | ✓ | ✓ |
| Filter | OFF | ✓ | ✓ |
| Output Switch | OFF* | ✓ | ✓ |
| Function | STD WAVE | ✓ | ✓ |
| Mode | CONTinuous | ✓ | ✓ |
| Burst Count | 3 | ✓ | ✓ |
| Trigger Input Mode | ASYNChro- nous | ✓ | ✓ |
| Trigger Output Mode | SERial | ✓ | ✓ |
| Standard Functions | | | |
| Sine | ⟨cycles⟩ | 1 | ✓ |
| | ⟨phase⟩ | 0 | ✓ |
| Square | ⟨cycles⟩ | 1 | ✓ |
| | ⟨duty cycle⟩ | 50% | ✓ |
| Pulse ± | ⟨cycles⟩ | 1 | ✓ |
| | ⟨delay⟩ | 0% | ✓ |
| | ⟨risetime⟩ | 10% | ✓ |
| | ⟨hightime⟩ | 30% | ✓ |
| | ⟨falltime⟩ | 10% | ✓ |
| | ⟨cycles⟩ | 1 | ✓ |
| | ⟨duty cycle⟩ | 100% | ✓ |
| | ⟨exponent⟩ | 5.00 | ✓ |
| Exponential ± | ⟨exponent⟩ | 2.00 | ✓ |
| | ⟨cycles⟩ | 1 | ✓ |
| Gaussian ± | ⟨cycles⟩ | 1 | ✓ |
| | ⟨phase⟩ | 0 | ✓ |
| Haversine | ⟨cycles⟩ | 5.50 | ✓ |
| | ⟨start cycles⟩ | 1 | ✓ |
| Circle | ⟨cycles⟩ | 10 | ✓ |
| | ⟨stop cycles⟩ | 1 | ✓ |
| Sine X over X | ⟨cycles⟩ | 10 | ✓ |
| | ⟨start cycles⟩ | 20 | ✓ |
| Linear Sweep | ⟨stop cycles⟩ | 0 | ✓ |
| | ⟨carrier cycles⟩ | 1 | ✓ |
| Log Sweep | ⟨carrier phase⟩ | ✓ | ✓ |
| | ⟨modulation cycles⟩ | ✓ | ✓ |
| AM | ⟨carrier cycles⟩ | ✓ | ✓ |
| | ⟨carrier phase⟩ | ✓ | ✓ |
| | ⟨modulation cycles⟩ | ✓ | ✓ |

RESET Functions (cont)

| PARAMETER | VALUE/STATUS | RESET | |
|-----------------|---------------------|---------------|------|
| | | ALL | CURR |
| SCM | ⟨modulation phase⟩ | 0 | ✓ |
| | ⟨modulation index⟩ | 50% | ✓ |
| | ⟨carrier cycles⟩ | 20 | ✓ |
| | ⟨carrier phase⟩ | 0 | ✓ |
| FM | ⟨modulation cycles⟩ | 1 | ✓ |
| | ⟨modulation phase⟩ | 0 | ✓ |
| | ⟨carrier cycles⟩ | 20 | ✓ |
| | ⟨carrier phase⟩ | 0 | ✓ |
| DC | ⟨modulation cycles⟩ | 1 | ✓ |
| | ⟨modulation phase⟩ | 0 | ✓ |
| | ⟨index⟩ | 10.00 | ✓ |
| Sync Selects | ⟨SYNC1⟩ | ENDPoint | ✓ |
| | ⟨SYNC2⟩ | Waveform | ✓ |
| | | RUN | |
| | ⟨SYNC3⟩ | ENDBlock | ✓ |
| Waveform Memory | ⟨numbers⟩ | 00 - 04 | ✓ |
| | ⟨size⟩ | 2000 points | ✓ |
| ARB WAVE | ⟨data⟩ | affected | ✓ |
| | ⟨size⟩ | 1000 points | ✓ |
| | ⟨data⟩ | sine, 1 cycle | ✓ |
| | | | NO |
| STD WAVE | ⟨numbers⟩ | 00 - 04 | ✓ |
| | ⟨size⟩ | 2000 points | ✓ |
| STD WAVE | ⟨data⟩ | affected | ✓ |
| | ⟨size⟩ | 1000 points | ✓ |
| STD WAVE | ⟨data⟩ | sine, 1 cycle | ✓ |
| | | | NO |

* When performing a RESET via the front panel, the instrument automatically changes to the OUTPUT menu.



PM 5150 Remote Command Set

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT | PARAMETERS | VALUES | DESCRIPTION |
|------------------------|------------|-------------|------------|---------|--|
| Common Commands | | | | | |
| *CLS | | | | | Clears all event and status registers. Also clears output queue if it immediately follows a Program Message Terminator. |
| *ESE(?) | | <NR>(ND) | | 0 - 255 | Sets the 8-bit mask in the ESE register. Query form returns the contents of the ESE register. |
| *ESR? | | <NR> | | 0 - 255 | Returns the contents of the ESR register. Once read, the ESR register is cleared. |
| *IDN? | | | | | Queries the instrument for its identification. The specific response is: PHILIPS PM5150, x.y, where x.y is the firmware level. |
| *OPC(?) | | | | | Sets the OPC bit (bit 0) in the ESR register when all pending instrument operations are completed. The query waits for all pending operations to complete then places a "1" in the output queue. |
| *RST | | | | | Equivalent to front-panel RESET CURR; returning the instrument to a default state. |

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## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)                | SHORT FORM | DATA FORMAT | PARAMETERS | VALUES  | DESCRIPTION                                                                                                                                                                   |
|-------------------------------|------------|-------------|------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *SRE(?)                       |            | <NR>(ND)    |            | 0 - 255 | Sets the 8-bit mask to enable and disable bits in the STB register. The query returns the value of the SRE register.                                                          |
| *STB?                         |            | <NR>        |            | 0 - 255 | Returns the value of the Status Byte. The Master Summary Status Bit (bit 6) is cleared when first read, but all other bits remain unchanged until the conditions are cleared. |
| *TRG                          |            |             |            |         | Equivalent to front-panel TRIG key.                                                                                                                                           |
| *TST?                         |            |             |            |         | Reserved for testing. No effect except to return ASCII "0".                                                                                                                   |
| *WAI                          |            |             |            |         | Wait-to-Continue. Has no effect since commands are processed sequentially.                                                                                                    |
| OPT?                          |            |             |            |         | GPIB (always returned: no longer an option)<br>Sequencer option installed: SEQ                                                                                                |
| <b>Configuration Commands</b> |            |             |            |         |                                                                                                                                                                               |
| CONFIGURE                     | CONF       |             |            |         | Root-level command for hierarchical Program Message Units.                                                                                                                    |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)         | SHORT FORM | DATA FORMAT                  | PARAMETERS | VALUES       | DESCRIPTION                                                                                                            |
|------------------------|------------|------------------------------|------------|--------------|------------------------------------------------------------------------------------------------------------------------|
| ⇒ HEADERS(?)           | HDRS(?)    |                              | ON / OFF   |              | ON = Query responses include header; OFF = Responses only return data. Query returns the current header configuration. |
| <b>System Commands</b> |            |                              |            |              |                                                                                                                        |
| EXECUTE                | EXEC       |                              |            |              | Equivalent to front-panel ENTER key; instructs the instrument to execute pending commands.                             |
| HOLD                   |            |                              | ON / OFF   |              | Equivalent to front-panel HOLD key; holds or releases the present level of output voltage.                             |
| RECALL                 | RCLL       | <code>&lt;NR&gt;\(ND)</code> |            | 0 - 30       | Recalls front-panel setups from the specified memory.                                                                  |
| REF_CLK_ADJ(?)         | RADJ(?)    | <code>&lt;NR&gt;</code>      |            | -2048 - 2047 | Adjusts reference clock by the specified factor. Query returns the current reference clock adjustment factor.          |
| REF_CLOCK(?)           | RCLK(?)    |                              | INT / EXT  |              | Sets the reference clock source to INTERNAL or EXTERNAL. Query returns the current reference clock source.             |
| RESET                  |            |                              | CURR / ALL |              | Resets instrument settings to default values.                                                                          |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)         | SHORT FORM | DATA FORMAT                  | PARAMETERS       | VALUES       | DESCRIPTION                                                                                                        |
|------------------------|------------|------------------------------|------------------|--------------|--------------------------------------------------------------------------------------------------------------------|
| RTNTOSTRT              | RTST       |                              | ON / OFF         |              | Equivalent to front-panel RTS key; when ON, returns the starting point of the output waveform.                     |
| SAMPLECLOCK            | SCLK       | <code>&lt;NR&gt;</code>      |                  | 0.1 - 20E6   | Sets/returns the sample clock frequency.                                                                           |
| STORE                  | STOR       | <code>&lt;NR&gt;\(ND)</code> |                  | 0 - 30       | Stores front panel setups into the specified memory.                                                               |
| TRIGGER_SEL(?)         | TRGSEL(?)  |                              | INT / MAN        |              | Sets trigger function to internal trigger or to manual/external trigger. The query form returns the current state. |
| TGRRATE(?)             | TGRR(?)    | <code>&lt;NR&gt;</code>      |                  | 0.02 - 10.0  | Sets/returns the trigger rate in seconds.                                                                          |
| TRIGGER                | TRIG       |                              | ON / OFF / PULSE |              | Sets the trigger to ON, OFF, or PULSE.                                                                             |
| <b>Output Commands</b> |            |                              |                  |              |                                                                                                                    |
| AMPLITUDE(?)           | AMPL(?)    | <code>&lt;NR&gt;</code>      |                  | 0.02 - 20.40 | Sets/returns the peak-to-peak output voltage.                                                                      |
| BURST(?)               |            | <code>&lt;NR&gt;\(ND)</code> |                  | 1 - 1048575  | Sets/returns the number of bursts.                                                                                 |
| CLOCK_SEL(?)           | CLKSEL(?)  |                              | INT / EXT        |              | Selects either internal or external sample clock source. Query returns current setting.                            |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)   | SHORT FORM | DATA FORMAT                                                      | PARAMETERS       | VALUES      | DESCRIPTION                                                                                                                                                    |
|------------------|------------|------------------------------------------------------------------|------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FILTER(?)        |            | ON / OFF                                                         |                  |             | Sets/returns output filter state ON or OFF.                                                                                                                    |
| FREQUENCY?       | FREQ?      | <b>&lt;NR&gt;</b>                                                |                  |             | Returns the calculated waveform repetition rate or the SCLK value with a negative sign if no FREQ value can be calculated, e.g., when a SEQUENCE is selected.  |
| FUNCTION(?)      | FUNC(?)    | <b>&lt;NR&gt;(ND)</b><br>STDW<br>ARB<br>SEQ<br>or<br>Wavfor<br>m | 0 - 99<br>0 - 99 |             | Selects the specified waveform or sequence to send to the output. E.g.: FUNC ARB,1 or FUNC,STDW. Query returns the currently selected wave or sequence number. |
| MODE(?)          |            | CONT/TRIG/GATE/<br>BURST/Toggle                                  |                  |             | Sets/returns the output signal mode.                                                                                                                           |
| OFFSET(?)        | OFST(?)    | <b>&lt;NR&gt;</b>                                                |                  | -9.4 - +9.4 | Sets/returns output offset voltage.                                                                                                                            |
| OUTPUT_SWITCH(?) | OUTSW(?)   |                                                                  | ON / OFF         |             | Equivalent to front-panel OUTPUT key. Query returns the state of the OUTPUT switch.                                                                            |
| READ_BURST?      | RBRST?     | <b>&lt;NR&gt;</b>                                                |                  | 1 - 1048575 | Returns the number of completed output bursts.                                                                                                                 |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)                   | SHORT FORM | DATA FORMAT           | PARAMETERS        | VALUES  | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------|------------|-----------------------|-------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SYNCSEL(?)                       |            | <b>&lt;NR&gt;(ND)</b> | ADDR / STATE      | 1, 2, 3 | Sets the selected sync pulse either to an address or a specific state within a waveform. See the entry for SYNC later in this table. SYNC1: pulse at the end point (ENDP) SYNC2: pulse is high during waveform run (WRUN) SYNC3: pulse at end point of each waveform burst (ENDB) within a sequence. Query returns the current state of the specified SYNC pulse. |
| TRGINMODE(?)                     |            |                       | SYNC / ASYNC      |         | Sets the trigger input mode to synchronous or asynchronous. Query returns the current mode of the input trigger.                                                                                                                                                                                                                                                  |
| TRGOUTMODE(?)                    |            |                       | SERIAL / PARALLEL |         | For multi-instrument triggering, sets the output to trigger in serial or parallel. Query returns the current output trigger mode.                                                                                                                                                                                                                                 |
| <b>Waveform Editing Commands</b> |            |                       |                   |         |                                                                                                                                                                                                                                                                                                                                                                   |
| WAVEFORM                         |            | WVFM                  |                   |         | Root-level command for hierarchical Program Message Units.                                                                                                                                                                                                                                                                                                        |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)                                                                                                                                                       | SHORT FORM | DATA FORMAT                                                             | PARAMETERS                                                                                         | VALUES                                                     | DESCRIPTION                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NOTES:</b>                                                                                                                                                        |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| 1. The remainder of this table consists of subcommands that must be preceded by <b>WVFM</b> :                                                                        |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| The symbol $\Rightarrow$ before the command name indicates that it is a subcommand of the <b>WVFM</b> hierarchical command.                                          |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| 2. Waveforms are listed alphabetically, not arranged in the order that they appear on the display.                                                                   |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| 3. All Waveform Editing commands apply identically to Arbitrary and to Standard Waveforms, with the following exceptions, which are also noted in the table entries: |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| A. <b>POSN</b> , <b>LEN</b> , <b>MINY</b> , <b>MAXY</b> , and <b>LINE</b> do not apply to Standard Waveforms.                                                        |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| B. <b>INVERT</b> keyword is only valid for <b>EXP</b> , <b>SAW</b> , <b>PULSE</b> , and <b>CIRCLE</b> Standard Waveforms.                                            |            |                                                                         |                                                                                                    |                                                            |                                                                                                                                                                                                                                        |
| $\Rightarrow$ AM                                                                                                                                                     |            | <b>⟨NR⟩</b><br><b>⟨NR⟩</b><br><b>⟨NR⟩</b><br><b>⟨NR⟩</b><br><b>⟨NR⟩</b> | Carrier Frequency<br>Carrier Phase<br>Modulation Frequency<br>Modulation Phase<br>Modulation Index | 1 - 8183<br>0° - 360°<br>1 - 8183<br>0° - 360°<br>0 - 100% | Generates a sine wave amplitude-modulated by a sine wave. The AM wave is stored in the currently selected waveform memory.                                                                                                             |
| $\Rightarrow$ CIRCLE                                                                                                                                                 |            | <b>⟨NR⟩⟨ND⟩</b><br><b>⟨NR⟩⟨ND⟩</b><br><b>⟨NR⟩⟨ND⟩</b>                   | Number of Repetitions<br>Phase<br>Slope                                                            | 0 - 1000<br>0° - 360°<br>NORM/ INVERT                      | Generates a semicircle in the selected waveform memory. The keywords NORM and INVERT are optional for Arbitrary Waveforms; not valid for STDW.<br>NORM = positive-going first half cycle.<br>INVERT = negative-going first half cycle. |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY)            | SHORT FORM   | DATA FORMAT                                              | PARAMETERS                                                                                         | VALUES                                                          | DESCRIPTION                                                                                                                                                                                                                                     |
|---------------------------|--------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\Rightarrow$ DC          |              | <b>⟨NR⟩</b>                                              | Y value                                                                                            | -2048 - +2047                                                   | Generates a horizontal line at Y value in the selected waveform memory.                                                                                                                                                                         |
| $\Rightarrow$ EXPONENTIAL | <b>EXP</b>   | <b>⟨NR⟩⟨ND⟩</b>                                          | Time Constant<br>Decay                                                                             | 0 - 20<br>NORM/ INVERT                                          | Generates a decaying exponential with the specified time constant (e <sup>x</sup> ) in the selected waveform memory. Decay specifier is optional for both Arbitrary and Standard Waveforms.<br>NORM = positive decay<br>INVERT = negative decay |
| $\Rightarrow$ FM          |              | <b>⟨NR⟩</b><br><b>⟨NR⟩</b><br><b>⟨NR⟩</b><br><b>⟨NR⟩</b> | Carrier Frequency<br>Carrier Phase<br>Modulation Frequency<br>Modulation Phase<br>Modulation Index | 1 - 8183<br>0° - 360°<br>1 - 8183<br>0° - 360°<br>0.01 - 100.00 | Generates a sine wave frequency-modulated by a sine wave in the selected waveform memory.                                                                                                                                                       |
| $\Rightarrow$ GAUSSIAN    | <b>GAUSS</b> | <b>⟨NR⟩</b>                                              | Exponent Power                                                                                     | 0.01 - 20                                                       | Generates a gaussian pulse with the specified exponent, e <sup>-x<sup>2</sup></sup> where x varies between +EXP and -EXP.                                                                                                                       |
| $\Rightarrow$ HAVERSINE   | <b>HSIN</b>  | <b>⟨NR⟩</b>                                              | Number of Repetitions                                                                              | 0.01 - 1000.00                                                  | Generates a haversine wave with the number of cycles specified. The basic shape is a sine wave shifted by 90°.                                                                                                                                  |

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                                                                                                                                                                                                                                                    | PARAMETERS                                                                     | VALUES                                                                   | DESCRIPTION                                                                                                                                                                                                                                                                                          |
|----------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ⇒ LINE         |            | $\langle NR \rangle$                                                                                                                                                                                                                                           | Starting Y value<br>Ending Y value                                             | -2048 - +2047                                                            | Generates a ramp with the specified coordinates in the selected waveform memory.                                                                                                                                                                                                                     |
| ⇒ LINEARSWEEP  | LINS       | $\langle NR \rangle$<br>$\langle NR \rangle$<br>$\langle NR \rangle$                                                                                                                                                                                           | Starting no. of cycles<br>Ending no. of cycles<br>Starting Phase*              | 1 - 1000<br>1 - 1000<br>0° - 360°                                        | Generates a linearly-swept sine wave with the number of starting and ending cycles specified. See note following Starting Phase parameter.                                                                                                                                                           |
| ⇒ LOGSWEEP     | LOGS       | $\langle NR \rangle$                                                                                                                                                                                                                                           | Starting no. of cycles<br>Ending no. of cycles<br>Starting Phase*              | 1 - 1000<br>1 - 1000<br>0° - 360°                                        | Generates a logarithmically-swept sine wave with the number of starting and ending cycles specified. See note following table regarding Starting Phase parameter.                                                                                                                                    |
| ⇒ NOISE        |            |                                                                                                                                                                                                                                                                |                                                                                |                                                                          | Generates pseudo-random noise in the selected waveform memory.                                                                                                                                                                                                                                       |
| ⇒ PULSE        |            | $\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$ | Number of Repetitions<br>Delay<br>Rise Time<br>High Time<br>Fall Time<br>Slope | 0 - 1000<br>0 - 100%<br>0 - 100%<br>0 - 100%<br>0 - 100%<br>NORM/ INVERT | Generates a pulse train with the number of repetitions specified. Delay, rise, high, and fall time are expressed as percentages of the period of the pulse. Slope specifier is optional for Arbitrary and Standard Waveforms. If slope is not specified, defaults to normal, a positive-going pulse. |

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                                                                                                                   | PARAMETERS                                                                     | VALUES                                         | DESCRIPTION                                                                                                                                                                                                                                                           |
|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ⇒ SAWTOOTH     | SAW        | $\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$ | Number of Repetitions<br>Duty Cycle<br>Slope                                   | 1 - 1000<br>1 to 100%<br>NORM/ INVERT          | Generates a sawtooth waveform with the number of cycles specified. Duty cycle is optional; 50% if unspecified. Slope is optional for both Arbitrary and Standard Waveforms, defaults to normal (positive-going) if unspecified.                                       |
| ⇒ SINE         |            | $\langle NR \rangle$<br>$\langle NR \rangle$                                                                                  | Number of Repetitions<br>Phase                                                 | 0 - 1000.00<br>0.00 - 360.00°                  | Generates a sine wave with the number of repetitions specified, beginning at the specified phase angle.                                                                                                                                                               |
| ⇒ SAW          |            | $\langle NR \rangle$<br>$\langle NR \rangle$<br>$\langle NR \rangle$                                                          | Carrier Frequency<br>Carrier Phase<br>Modulation Frequency<br>Modulation Phase | 1 - 8183<br>0° - 360°<br>1 - 8183<br>0° - 360° | Generates a sine wave with suppressed carrier.                                                                                                                                                                                                                        |
| ⇒ SQUARE       |            | $\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$ | Number of Repetitions<br>Duty Cycle<br>Slope                                   | 1 - 1000<br>1 - 100%<br>NORM/ INVERT           | Generates a square wave with the number of repetitions specified. Duty cycle is optional, 50% if unspecified. Slope is optional for Arbitrary Waveforms, not valid for Standard Waveforms. Slope defaults to normal (positive-going first half-cycle) if unspecified. |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                             | PARAMETERS                            | VALUES                   | DESCRIPTION                                                                                                                                                                                                                                                |
|----------------|------------|-----------------------------------------|---------------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ⇒ SINE_X_OVR_X | SXX        | $\langle NR \rangle \langle ND \rangle$ | Ringing frequency multiplier<br>Slope | 4 - 1000<br>NORM/ INVERT | Generates the function $\sin(x)/x$ as a waveform with the specified number of cycles. Slope is optional for Arbitrary Waveforms, not valid for Standard; defaults to normal (positive-going first half-cycle) if unspecified.                              |
| ⇒ TRIANGLE     |            | $\langle NR \rangle \langle ND \rangle$ | Number of Repetitions<br>Slope        | 1 - 1000<br>NORM/ INVERT | Generates a triangle wave in the currently selected waveform memory, with the specified number of cycles. Slope is optional for Arbitrary Waveforms, not valid for Standard Waveforms; if unspecified, slope defaults to normal (rising).                  |
| ⇒ LENGTH(?)    | LEN(?)     | $\langle NR \rangle \langle ND \rangle$ |                                       | 0 - 32768                | Sets the length in data points that any succeeding waveform generation function will create. Functional limits are 0 to SIZE minus POSITION, otherwise a device error occurs. Not valid for Standard Waveforms. Query returns the current value of LENGTH. |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                             | PARAMETERS | VALUES        | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                   |
|----------------|------------|-----------------------------------------|------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ⇒ MAXY(?)      |            | $\langle NR \rangle$                    |            | -2048 - +2047 | Sets the maximum Y value to be produced when generating a waveform. Not valid for Standard Waveforms. Query returns the current value of MAXY.                                                                                                                                                                                                                |
| ⇒ MINY(?)      |            | $\langle NR \rangle$                    |            | -2048 - +2047 | Sets the minimum Y value to be produced when generating a waveform. Not valid for Standard Waveforms. Query returns the current value of MINY.                                                                                                                                                                                                                |
| ⇒ POSITION(?)  | POSN(?)    | $\langle NR \rangle \langle ND \rangle$ |            | 0 - 32768     | Sets/returns the starting position, in the currently selected waveform memory, where new waveform points will be written. The maximum starting position is the size of the memory. Not valid for Standard Waveforms. After a function, (e.g., SINE), is written, POSITION automatically increments to the value of SIZE, to point to the next new data point. |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                             | PARAMETERS | VALUES           | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------|------------|-----------------------------------------|------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                |            | $\langle NR \rangle \langle ND \rangle$ |            | 0,<br>32 - 32768 | Sets/returns the memory size in number of points of the currently selected waveform. The size can be from zero to the total amount of free memory space. If the Standard Waveform (STDW) is currently selected, the existing waveform is stretched or squeezed to fit the new size. If the selected waveform is other than STDW, and SIZE is being enlarged, new points (set to 0) are added at the end of the waveform, reducing its size. Sending 0 size deletes the waveform.<br><br>⇒ SIZE(?) |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                             | PARAMETERS                                                                                                              | VALUES                            | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                |
|----------------|------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                |            | $\langle NR \rangle \langle ND \rangle$ | Sync Number<br>$\langle NR \rangle \langle ND \rangle$ Start Position<br>$\langle NR \rangle \langle ND \rangle$ Length | 1, 2, 3<br>0 - 32767<br>0 - 32768 | Installs a sync pulse into the specified channel. The Start Position specifies the location in the selected waveform memory where the pulse begins, and Length specifies the total length of the pulse.<br><br>Start Position range: 0 to SIZE minus 1.<br>Length range: 0 to SIZE minus POSITION.<br><br>Query form returns the starting position and length of the specified sync pulse. |
|                |            | $\langle NR \rangle \langle ND \rangle$ | Waveform Number - or STDW                                                                                               | 0 - 99<br>STDW                    | Selects one of the 100 waveform memories, or the Standard Waveform to be used for editing or creating waves, e.g., WVFM:WAVE 0 or WVFM:WAVE STDW. POSITION is set to zero, LENGTH is set to SIZE. Query returns the number of the currently selected waveform memory, e.g., WVFM:ARB 0 or WVFM:ARB STDW.<br><br>⇒ WAVE(?)                                                                  |

| COMMAND(QUERY)                    | SHORT FORM | DATA FORMAT                                                        | PARAMETERS                 | VALUES                     | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------|------------|--------------------------------------------------------------------|----------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Waveform Transfer Commands</b> |            |                                                                    |                            |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| ⇒ MEMORY(?)                       |            | <code>&lt;NR&gt;\{ND&gt;</code><br><code>&lt;NR&gt;\{ND&gt;</code> | Starting Address<br>Data   | 0 - 32767<br>-2048 - +2047 | This command only applies to Arbitrary Waves. It sends either individual data points or a block of data into the selected waveform memory beginning at the specified address. The data block can be any length, and may be sent either as individual data points in the <code>&lt;NR&gt;</code> format, or as a data block, high byte first. The query applies to both Standard and Arbitrary waves and returns a single word of data in the range -2048 to +2047, beginning at the specified address. |
| ⇒ MEM_BLOCK?                      | MBLK?      | <code>&lt;NR&gt;\{ND&gt;</code><br><code>&lt;NR&gt;\{ND&gt;</code> | Starting Address<br>Length | 0 - 32767<br>0 - 2048      | Returns the number of data points specified in length beginning at the specified address. Each data point is a 2-byte word, high byte first. Response is constructed as follows:<br><br>Address in <code>&lt;NR&gt;</code> format<br>Comma(,)<br>Data in Definite Length Arbitrary Block format.                                                                                                                                                                                                       |

| COMMAND(QUERY)                     | SHORT FORM | DATA FORMAT                                                        | PARAMETERS                                                                   | VALUES                                     | DESCRIPTION                                                                                                                                                                                                                                          |
|------------------------------------|------------|--------------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sequence Generator Commands</b> |            |                                                                    |                                                                              |                                            |                                                                                                                                                                                                                                                      |
| ⇒ ADD-SEQ(?)                       |            | <code>&lt;NR&gt;\{ND&gt;</code><br><code>&lt;NR&gt;\{ND&gt;</code> | Sequence Number<br>Waveform Number<br>Burst Count<br>Sequence Step<br>Number | 0 - 99<br>0 - 99<br>0 - 1048575<br>0 - 999 | Adds a series of waveforms to a specified sequence. Waveform parameters are passed in groups of three: waveform, number of times to repeat the waveform, and the sequence number to use. In the query form, all values are returned as integers.     |
| ⇒ AUTOSEQUENCE(?)                  | AUTO       | <code>&lt;NR&gt;\{ND&gt;</code><br><code>&lt;NR&gt;\{ND&gt;</code> | First Sequence Step<br>Step Number                                           | 0 - 999<br>0 - 999                         | Configures the automatic sequence step generator to begin at the specified first sequence step, and increment by the step number to the next sequence number. This command is always used in conjunction with the SEQ and SEQB commands (see below). |
| ⇒ SEQUENCE ...                     | SEQ        | <code>&lt;NR&gt;\{ND&gt;</code><br><code>&lt;NR&gt;\{ND&gt;</code> | Sequence Number<br>Waveform Numbers                                          | 0 - 99<br>0 - 99                           | Constructs a sequence having the specified sequence number composed of a series of waveforms as specified. Burst count is set to 1 for each waveform. If no waveform number is supplied, the block is deleted.                                       |

## PM 5150 Remote Command Set (cont)

| COMMAND(QUERY) | SHORT FORM | DATA FORMAT                                                                                                                   | PARAMETERS                                        | VALUES                          | DESCRIPTION                                                                                                                                                                                                                                          |
|----------------|------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ⇒ SEQBURST     | SEQB       | $\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$<br>$\langle NR \rangle \langle ND \rangle$ | Sequence Number<br>Waveform Number<br>Burst Count | 0 - 99<br>0 - 99<br>0 - 1048575 | Constructs a sequence having the specified sequence number composed of a series of waveforms as specified. Waveform parameters are passed in sets of two: the next waveform in the sequence, and the number of times the waveform is to be repeated. |

## NOTES:

1. The notation  $\langle NR \rangle$  in the DATA FORMAT column indicates that the numeric value sent to the generator must be represented as a decimal number.
2. The notation  $\langle ND \rangle$  in the DATA FORMAT column indicates that the numeric value sent to the generator can be represented as a binary, octal, or hexadecimal number as described under the heading "Non-Decimal Numeric Program Data" earlier in this section. Values returned by queries are real signed numbers.
3. When programming a sweep of standard waveforms (LINS or LOGS commands), a starting phase must be given even though it is ignored. Sweeps always start at 0°.

## Notes

Notes